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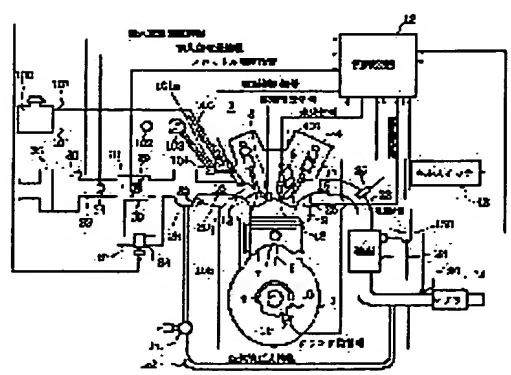
(54) ENGINE CONTROL METHOD

(57)Abstract:

PROBLEM TO BE SOLVED: To burn fuel in a lean-burning state and to improve fuel consumption by detecting an actual combustion ratio until a prescribed crank angle and comparing a detected combustion ratio with a target combustion ratio and controlling a fuel supply amount such that a fuel supply amount is increased (decreased) when the detected combustion ratio is smaller (larger) than the target combustion ratio.



SOLUTION: When an engine is operated in a state of a middle/high engine speed where, in a controller 12, a throttle opening is a prescribed value or more and an engine speed is a prescribed value or more and the change ratio of the throttle opening is a prescribed value or less, a variable C is made 1. When the engine is operated in a transition state where the change ratio of the throttle opening is a prescribed value or

more, the variable C is made 2 and, when the throttle opening, the engine is judged to be controlled in a lean- burning state and variable C is a prescribed value or less and the engine speed is in a prescribed range, the variable C is made 3. After the variable is set in these ways, a target combustion ratio corresponding to the engine speed and the load is determined by using map data and is compared with a detected combustion ratio to thereby control the injection amount of an injector.

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CLAIMS

[Claim(s)]
[Claim 1] When it is the initial value of the amount of fuel supply according to a load at least and the fuel is supplied to an engine, It has data with the initial value of the amount of fuel supply set up so that a lean mixture might be formed in a combustion chamber. 1 or two or more combustion rates in 1 or two or more predetermined crank angles [whether it holds in memory among a load or an engine speed as map data of 1 or two or more target combustion rates at least corresponding to one side, and] 1 or two or more crank angles which reach 1 or two or more predetermined combustion rates Whether it holds in memory among a load or an engine speed as map data of 1 or two or more target crank angles at least corresponding to one side on the other hand The actual combustion rate to these 1 or two or more predetermined crank angles is detected. the comparison with this detection combustion rate and a target combustion rate -- being based -- the direction of a detection combustion rate -- smallness -- the time -- the amount of fuel supply -- increasing -- The actual crank angle which decreases the amount of fuel supply or reaches these 1 or two or more predetermined combustion rates when the direction of a detection combustion rate becomes size is detected. The control approach of the engine characterized by carrying out one amount control of fuel supply of whether the amount of fuel supply is decreased while the amount of fuel supply is increased based on the comparison with this detection crank angle and a target crank angle while the direction of a target crank angle is progressing, and the direction of a detection value crank angle is progressing.
[Claim 2] Allowance width of face is given to a target combustion rate. The larger 1st target combustion rate than the target combustion rate of map data, The 2nd target combustion rate smaller than the target combustion rate of map data is set up. the direction of said detection combustion rate -- the 2nd target combustion rate -- smallness -- the time -- the amount of fuel supply -- increasing -- When the direction of said detection combustion rate consists of a 1st target combustion rate size, the amount of fuel supply is decreased. The 1st target crank angle which it is made not to change the amount of fuel supply, or gave allowance width of face to the target crank angle, and progressed from the target crank angle of map data when said detection combustion rate was between the 1st target combustion rate and the 2nd target combustion rate, The 2nd target crank angle which was late for the target crank angle of map data is set up. While the detection crank angle is progressing from said 1st target crank angle, the amount of fuel supply is decreased. When the direction of a detection value crank angle is behind the 2nd target crank angle, the amount of fuel supply is increased. The control approach of the engine according to claim 1 characterized by carrying out one to which it is made not to change the amount of fuel supply of those amount control of fuel supply when said detection crank angle is between the 1st target crank angle and the 2nd target crank angle.
[Claim 3] The control approach of the engine according to claim 1 or 2 characterized by carrying out one of the amount control of fuel supply at the time at least of one side among whether a load is smaller than a predetermined value or there are few engine speeds than a predetermined value.
[Claim 4] It has the initial value of ignition timing at least corresponding to one side as data among a load or an engine speed. 1 or two or more combustion rates in 1 or two or more predetermined crank angles [whether it holds in memory among a load or an engine speed as map data of 1 or two or more target combustion rates at least corresponding to one side, and] 1 or two or more crank angles which reach 1 or two or more predetermined combustion rates Whether it holds in memory among a load or an engine speed as map data of 1 or two or more target crank angles at least corresponding to

one side on the other hand The actual combustion rate to these 1 or two or more predetermined crank angles is detected. the comparison with this detection combustion rate and a target combustion rate -- being based -- the direction of a detection combustion rate -- smallness -- an event -- a fire stage -- advancing -- The actual crank angle which delays ignition timing when the direction of a detection combustion rate becomes size, or reaches these 1 or two or more predetermined combustion rates is detected. Based on the comparison with this detection crank angle and a target crank angle, a fire stage is set forward the event of the direction of a target crank angle progressing. The control approach of the engine according to claim 1 to 3 characterized by carrying out one ignition-timing control of whether a fire stage is delayed the event of the direction of a detection value crank angle progressing.

[Claim 5] The control approach of the engine according to claim 4 characterized by carrying out only ignition-timing control based on said combustion rate when there is not a load or an engine speed in said conditions while carrying out ignition-timing control and said amount control of fuel supply based on said detection combustion rate or the detection crank angle at the time at least of one side among whether a load is smaller than a predetermined value or there are few engine speeds than a predetermined value.

[Claim 6] The control approach of the engine according to claim 4 or 5 characterized by carrying out ignition-timing control and the amount control of fuel supply by turns.

[Claim 7] The control approach of the engine according to claim 4 or 5 characterized by carrying out ignition-timing control of the 1st count of predetermined, and the amount control of fuel supply of the 2nd count of predetermined by turns.

[Claim 8] The control approach of the engine according to claim 7 characterized by making [many] it whether it is the same than the 2nd count of predetermined in the 1st count of predetermined.

[Claim 9] The control approach of the engine according to claim 1 to 8 characterized by having data of the initial value of the amount of fuel supply which the engine load set up so that the air-fuel ratio of smallness I see and a lean mixture could be enlarged while it is the initial value of the amount of fuel supply according to a load at least, and setting up so that a lean mixture may be formed in a combustion chamber when supplying the fuel to an engine.

[Claim 10] Carry out ignition-timing control based on said detection combustion rate or a detection crank angle, and said amount control of fuel supply. The target combustion rate used at the time of one [at least] 1st service condition among whether a load is smaller than a predetermined value or there are few engine speeds than a predetermined value The control approach of the engine according to claim 5 to 8 characterized by making it smaller than the target combustion rate used at the time of the 2nd service condition which carries out only ignition-timing control based on said detection combustion rate or a detection crank angle.

[Claim 11] Said detection combustion rate or said detection crank angle The crank angle from after termination of an exhaust stroke to the early stages of a compression stroke, and the crank angle from compression stroke initiation to ignition, The control approach of the engine according to claim 1 to 10 characterized by detecting the firing pressure in at least four crank angles which consist of two crank angles in the period from ignition initiation to exhaust stroke initiation, and making it compute based on these firing-pressure data.

[Translation done.]

* NOTICES *

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the control approach of a two-cycle jump-spark-ignition engine or a four-cycle jump-spark-ignition engine.
[0002]
[Description of the Prior Art] In a two-cycle jump-spark-ignition engine or a four-cycle jump-spark-ignition engine, O2 sensor is arranged on an exhaust pipe way, A/F value is computed from exhaust gas concentration, and there are some which control the amount of fuel supply or an air flow rate, and reduce NOx so that this calculation value may be brought close to desired value.
[0003] Moreover, the pressure of a combustion chamber is detected, an engine mean effective pressure is computed, and there are some which perform feedback control about ignition timing based on this calculation data.
[0004]
[Problem(s) to be Solved by the Invention] Since the lean combustion and low fuel consumption which were stabilized also in the load field in low are obtained based on this conventional technique, it is possible to carry out this feedback control.
[0005] However, even if it brings only A/F value close to desired value, a combustion condition changes with ignition timing, a stable revolution is no longer obtained or the part NOx value to which an engine output declines and an engine output becomes high becomes high.
[0006] Moreover, an engine mean effective pressure is computed, and even if it can feed back ignition timing based on this calculation data and can heighten an engine output, a NOx value becomes high when combustion is rapid.
[0007] This invention was made in view of this point, and he aims at offering the control approach of the engine which makes lean combustion possible and raises fuel consumption, an artificer discovering that there is correlation with the combustion rate high to engine power and exhaust air emission to a predetermined crank angle, and reducing exhaust air emission.
[0008]
[Means for Solving the Problem] In order to solve said technical problem and to attain the object, the control approach of the engine invention according to claim 1 When it is the initial value of the amount of fuel supply according to a load at least and the fuel is supplied to an engine, It has data with the initial value of the amount of fuel supply set up so that a lean mixture might be formed in a combustion chamber. 1 or two or more combustion rates in 1 or two or more predetermined crank angles [whether it holds in memory among a load or an engine speed as map data of 1 or two or more target combustion rates at least corresponding to one side, and] 1 or two or more crank angles which reach 1 or two or more predetermined combustion rates Whether it holds in memory among a load or an engine speed as map data of 1 or two or more target crank angles at least corresponding to one side on the other hand The actual combustion rate to these 1 or two or more predetermined crank angles is detected. the comparison with this detection combustion rate and a target combustion rate -- being based -- the direction of a detection combustion rate -- smallness -- the time -- the amount of fuel supply -- increasing -- The actual crank angle which decreases the amount of fuel supply or reaches these 1 or two or more predetermined combustion rates when the direction of a detection combustion rate becomes size is detected. Based on the comparison with this detection crank angle

and a target crank angle, while the direction of a target crank angle is progressing, the amount of fuel supply is increased, and while the direction of a detection value crank angle is progressing, it is characterized by carrying out one amount control of fuel supply of whether the amount of fuel supply is decreased.

[0009] Thus, the actual combustion rate to 1 or two or more predetermined crank angles is detected. the comparison with this detection combustion rate and a target combustion rate -- being based -- the direction of a detection combustion rate -- smallness -- the time -- the amount of fuel supply -- increasing -- The actual crank angle which decreases the amount of fuel supply or reaches these 1 or two or more predetermined combustion rates when the direction of a detection combustion rate becomes size is detected. Based on the comparison with this detection crank angle and a target crank angle, while the direction of a target crank angle is progressing, the amount of fuel supply is increased. Carrying out one amount control of fuel supply of whether the amount of fuel supply is decreased, and reducing exhaust air emission, while the direction of a detection value crank angle is progressing, lean combustion is made possible and fuel consumption is raised.

[0010] The control approach of the engine invention according to claim 2 Allowance width of face is given to a target combustion rate. The larger 1st target combustion rate than the target combustion rate of map data, The 2nd target combustion rate smaller than the target combustion rate of map data is set up. the direction of said detection combustion rate -- the 2nd target combustion rate -- smallness -- the time -- the amount of fuel supply -- increasing -- When the direction of said detection combustion rate consists of a 1st target combustion rate size, the amount of fuel supply is decreased. The 1st target crank angle which it is made not to change the amount of fuel supply, or gave allowance width of face to the target crank angle, and progressed from the target crank angle of map data when said detection combustion rate was between the 1st target combustion rate and the 2nd target combustion rate, The 2nd target crank angle which was late for the target crank angle of map data is set up. While the detection crank angle is progressing from said 1st target crank angle, the amount of fuel supply is decreased. When the direction of a detection value crank angle is behind the 2nd target crank angle, the amount of fuel supply is increased. When said detection crank angle is between the 1st target crank angle and the 2nd target crank angle, it is characterized by carrying out one to which it is made not to change the amount of fuel supply of those amount control of fuel supply.

[0011] Thus, lean combustion makes possible and fuel consumption raises, giving allowance width of face to a target combustion rate, giving allowance width of face to a target crank angle based on the target combustion rate of map data, performing the amount control of fuel supply based on whenever [easy and crank-angle / which reaches the combustion rate and the predetermined combustion rate to a predetermined crank angle at accuracy] by carrying out the amount control of fuel supply from the target crank angle of map data, and reducing exhaust-air emission.

[0012] The control approach of the engine invention according to claim 3 is characterized by carrying out one of the amount control of fuel supply at the time at least of one side among whether a load is smaller than a predetermined value or there are few engine speeds than a predetermined value.

[0013] Thus, the amount control of fuel supply is performed based on a load or an engine speed, and engine power is stabilized.

[0014] The control approach of the engine invention according to claim 4 It has the initial value of ignition timing at least corresponding to one side as data among a load or an engine speed. 1 or two or more combustion rates in 1 or two or more predetermined crank angles [whether it holds in memory among a load or an engine speed as map data of 1 or two or more target combustion rates at least corresponding to one side, and] 1 or two or more crank angles which reach 1 or two or more predetermined combustion rates Whether it holds in memory among a load or an engine speed as map data of 1 or two or more target crank angles at least corresponding to one side on the other hand The actual combustion rate to these 1 or two or more predetermined crank angles is detected. the comparison with this detection combustion rate and a target combustion rate -- being based -- the direction of a detection combustion rate -- smallness -- an event -- a fire stage -- advancing -- The actual crank angle which delays ignition timing when the direction of a detection combustion rate becomes size, or reaches these 1 or two or more predetermined combustion rates is detected. Based

on the comparison with this detection crank angle and a target crank angle, a fire stage is set forward the event of the direction of a target crank angle progressing, and it is characterized by carrying out one ignition-timing control of whether a fire stage is delayed the event of the direction of a detection value crank angle progressing.
[0015] Thus, the actual combustion rate to 1 or two or more predetermined crank angles is detected. the comparison with this detection combustion rate and a target combustion rate -- being based -- the direction of a detection combustion rate -- smallness -- an event -- a fire stage -- advancing -- The actual crank angle which delays ignition timing when the direction of a detection combustion rate becomes size, or reaches these 1 or two or more predetermined combustion rates is detected. Based on the comparison with this detection crank angle and a target crank angle, a fire stage is set forward the event of the direction of a target crank angle progressing. Carrying out one ignition-timing control of whether a fire stage is delayed the event of the direction of a detection value crank angle progressing, performing ignition-timing control based on the combustion rate to a predetermined crank angle, and reducing exhaust air emission, lean combustion is made possible and fuel consumption is raised.
[0016] While it carries out ignition-timing control and said amount control of fuel supply based on said detection combustion rate or a detection crank angle at the time at least of one side among whether a load is smaller than a predetermined value or there are few engine speeds than a predetermined value, the control approach of the engine invention according to claim 5 is characterized by to carry out only ignition-timing control based on said combustion rate, when there is not a load or an engine speed in said conditions.
[0017] Thus, reducing exhaust air emission by carrying out effectively ignition-timing control based on a detection combustion rate or a detection crank angle, and ignition-timing control based on a combustion rate, lean combustion is made possible and fuel consumption is raised.
[0018] The control approach of the engine invention according to claim 6 is characterized by carrying out ignition-timing control and the amount control of fuel supply by turns.
[0019] Thus, carrying out ignition-timing control and the amount control of fuel supply by turns, and reducing exhaust air emission, lean combustion is made possible and fuel consumption is raised.
[0020] The control approach of the engine invention according to claim 7 is characterized by carrying out ignition-timing control of the 1st count of predetermined, and the amount control of fuel supply of the 2nd count of predetermined by turns.
[0021] Thus, carrying out ignition-timing control of the 1st count of predetermined, and the amount control of fuel supply of the 2nd count of predetermined by turns, and reducing exhaust air emission, lean combustion is made possible and fuel consumption is raised.
[0022] The control approach of the engine invention according to claim 8 is characterized by making [many] it whether it is the same than the 2nd count of predetermined in the 1st count of predetermined.
[0023] Thus, making [many] it whether it is the same in the 1st count of predetermined, performing the amount control of fuel supply effectively, and reducing exhaust air emission from the 2nd count of predetermined, lean combustion is made possible and fuel consumption is raised.
[0024] Smallness I see, the control approach of the engine invention according to claim 9 is the initial value of the amount of fuel supply according to a load at least, and while setting up so that a lean mixture may be formed in a combustion chamber when supplying the fuel to an engine, the engine load is characterized by having data of the initial value of the amount of fuel supply set up so that the air-fuel ratio of a lean mixture could be enlarged.
[0025] Thus, having data of the initial value of the amount of fuel supply, securing accuracy and easy control, and reducing exhaust air emission, lean combustion is made possible and fuel consumption is raised.
[0026] The control approach of the engine invention according to claim 10 Carry out ignition-timing control based on said detection combustion rate or a detection crank angle, and said amount control of fuel supply. The target combustion rate used at the time of one [at least] 1st service condition among whether a load is smaller than a predetermined value or there are few engine speeds than a predetermined value It is characterized by making it smaller than the target combustion rate used at the time of the 2nd service condition which carries out only ignition-timing control based on said

detection combustion rate or a detection crank angle.
[0027] Thus, making it smaller than the target combustion rate which uses the target combustion rate used at the time of the 1st service condition at the time of the 2nd service condition which carries out only ignition-timing control, performing the amount control of fuel supply proper, and reducing exhaust air emission, lean combustion is made possible and fuel consumption is raised.
[0028] The control approach of the engine invention according to claim 11 Said detection combustion rate or said detection crank angle The crank angle from after termination of an exhaust stroke to the early stages of a compression stroke, and the crank angle from compression stroke initiation to ignition, The firing pressure in at least four crank angles which consist of two crank angles in the period from ignition initiation to exhaust stroke initiation is detected, and it is characterized by making it compute based on these firing-pressure data.
[0029] Thus, a firing pressure can be detected and it can compute appropriately based on firing-pressure data.
[0030]
[Embodiment of the Invention] Hereafter, the control approach of the engine this invention is explained to a detail based on a drawing.
[0031] Drawing 1 is a block diagram of the jump-spark-ignition type four stroke cycle engine which is two or more cylinders with which this invention is applied. This engine 1 is constituted by a crank case 2, and the cylinder body 3 and the cylinder head 4 of that upper part. In a cylinder body 3, it is equipped with a piston 7 possible [sliding] through a connecting rod 8, and the connecting rod 8 is connected with the crankshaft 9. A crankshaft 9 is equipped with the flywheel starter gear 10 which have a predetermined number of teeth, and it has the crank angle sensor 11 which serves as the engine speed sensor for detecting the revolution location of these flywheel starter gear 10, and measuring a crank angle and an engine speed. A combustion chamber 13 is formed between the cylinder head 4 and a piston 7, and the ignition plug 400 is formed so that this combustion chamber 13 may be attended.
[0032] Moreover, the combustion room pressure sensor 5 for detecting the firing pressure in a combustion chamber 13 is formed in a cylinder head 4 side. The cooling water jacket 6 is formed in the suitable location of the cylinder head 4 and a cylinder body 3. In a combustion chamber 13, a flueway 15 and the inhalation-of-air path 16 are open for free passage, and an exhaust valve 17 and an inlet valve 18 are formed in the opening, respectively. In the middle of the exhaust pipe 22 connected to the flueway 15, the catalysts 23, such as a three way component catalyst for exhaust gas clarification, are established, and the muffler 24 is formed in the edge. The oxygen density sensor (O2 sensor) 25 and the exhaust pipe temperature sensor 120 are formed in an exhaust pipe 22, and it connects with the control unit 12, respectively.
[0033] The cylinder head 4 is equipped with a temperature sensor 26, and the temperature information on a combustion chamber 13 is sent to a control unit 12. Moreover, a sensor 150 is formed in a catalyst 23 whenever [catalyst temperature / which was connected with the control unit 12]. The kill switch 43 of an engine 1 is further connected to a control device 12, and the halt information on engine drive control is acquired.
[0034] On the other hand, an inlet pipe 20 is connected to the inhalation-of-air path 16, and an inlet pipe 20 is connected with each cylinder through the inhalation-of-air distribution tube 28. The inhalation-of-air distribution tube 28 is equipped with the pressure-of-induction-pipe force sensor 32, and pressure-of-induction-pipe force information is sent to a control unit 12. The inhalation-of-air distribution tube 28 and an exhaust pipe 22 are connected, and the EGR tubing 152 is formed. The EGR regulator valve 151 connected with the control unit 12 is formed in the EGR tubing 152. An air cleaner 35 is ****(ed) by the inhalation-of-air distribution tube 28 through an inlet pipe 33. The inhalation air temperature sensor 36 is formed in an air cleaner 35, and inhalation air-temperature information is sent to a control unit 12. The inspired-air-volume regulator 30 is formed in the middle of an inlet pipe 33, and the inspired-air-volume regulator 30 is equipped with the throttle valve 29.
[0035] The throttle opening sensor 31 is formed in a throttle valve 29, and this throttle opening sensor 31 is connected with a control unit 12. The throttle-valve detour path 37 is established in the inlet pipe 33 of inspired-air-volume regulator 30 part, and the detour path opening regulator valve 38 is formed in this detour path 37. The detour path opening regulator valve 38 is connected with a

control unit 12. In an inlet pipe 33, the heat ray type inhalation air content sensor 34 is formed, and inhalation air content information is sent to a control unit 12.

[0036] An injector 105 is formed in the upstream of the inlet valve 18 of the inhalation-of-air path 16 for every inlet port of each cylinder. An injector 105 is connected with a control unit 12, and the control signal of the optimal injection quantity calculated according to operational status is sent. A fuel is sent to each injector 105 through fuel pipe 101a connected with each cylinder. Fuel pipe 101a branches from the fuel distribution tube 104, it lets a fuel feeding pipe 101 pass from a fuel tank 100 to this fuel distribution tube 104, and a fuel is further sent by the fuel pump 103 through a filter 102. The fuels which were not injected from an injector 105 are collected through the fuel return pipe 107 in a fuel tank 100. A regulator 106 is formed in the fuel return pipe 107, and fuel injection pressure is kept constant.

[0037] Drawing 2 is the flow chart of the main routine which controls various engine operational status. Each step is explained below.

[0038] Step S11: Initialization is performed and initial value is set to each flag value and each variable value.

[0039] Step S12 : The inhalation air-temperature information from the inhalation air temperature sensor 36, The inhalation air content information from the heat ray type inhalation air content sensor 34, the throttle opening information from the throttle opening sensor 31, Whenever [from a sensor 150 / catalyst temperature] Information, [whenever / pressure-of-induction-pipe force information / from the pressure-of-induction-pipe force sensor 32 / and catalyst temperature] The crank angle information from the crank angle sensor 11, the temperature information from a temperature sensor 26, The exhaust pipe temperature information from the exhaust pipe temperature sensor 120, the oxygen density information from the oxygen density sensor 25, and the oil residue information from a non-illustrated oil sensor are incorporated, and the data is memorized to memory A (i). An engine load can be grasped as an accelerator location or a throttle opening. If this throttle opening and engine speed are decided, since an inhalation air content is decided the case at the time of steady operation, an inhalation air content can be detected directly and it can be regarded as an engine load. Moreover, if an engine speed is decided, since inlet-pipe negative pressure has the fixed relation to a throttle opening, inlet-pipe negative pressure can be detected and it can be regarded as an engine load.

[0040] Step S13: Incorporate switch information, such as ON of the main switch which is not illustrated [ON of the kill switch 43, OFF and], OFF and ON of a non-illustrated starting switch, and OFF, and memorize to memory B (i). The kill switch 43 is a switch for emergency shut downs, and the engine for small marine vessels is equipped with it without preparing for the engine for cars.

[0041] Step S14: Operational status judges based on the sensor information incorporated in said step 12, and the switch information incorporated at said step 13, and input the value corresponding to the variable C in memory corresponding to this operational status **, **, **, **, **, **, **, **, **, and A**.

[0042] Operational status ** ... Beyond a predetermined value, an engine speed judges with a MBT (Minimum Advance Ignition for Best Torque) control state in the fixed accelerator condition that the rate of change of beyond a predetermined value and a throttle opening is not in the inside high-speed revolution below a predetermined value, an inside high-speed load, and a sudden acceleration-and-deceleration condition, or a ** accelerator actuation condition, and a throttle opening carries out memory of 1 to Variable C.

[0043] Operational status ** ... When the rate of change of a throttle opening is beyond a predetermined value, it judges with transient operational status and memory of 2 is carried out to Variable C.

[0044] Operational status ** ... When below a predetermined value and an engine speed are between predetermined region, for example, 1000rpm, - 5000rpm, they judge with a lean combustion control state, and a throttle opening carries out memory of 3 to Variable C.

[0045] Operational status ** ... An engine speed judges with OBAREBO more than predetermined threshold value, engine temperature judges with abnormality operational status at the time of engine abnormal conditions, such as overheat beyond a predetermined value, and memory of 4 is carried out to Variable C.

[0046] Operational status ** ... When engine temperature is below a predetermined value and a starting switch ON, it judges with a cold start condition and memory of 5 is carried out to Variable C.
[0047] Operational status ** ... At the time of a main switch OFF or the kill switch OFF, it judges with an engine shutdown demand condition, and memory of 6 is carried out to Variable C.
[0048] Operational status ** ... When below a predetermined value and Idle SW (throttle close by-pass bulb completely SW) are ON, they judge with an idle mode, and the time of clutch neutrality or an engine speed carries out memory of 7 to Variable C.
[0049] Operational status ** ... When a switch is ON in EGR control (control the recirculation of a part of exhaust gas is carried out [control] to an inhalation-of-air system), it judges with the EGR control mode, and memory of 8 is carried out to Variable C.
[0050] Operational status ** ... When beyond a predetermined value and a starting switch are ON, they usually judge with an engine start condition, and engine temperature carries out memory of 9 to Variable C.
[0051] Operational status A** ... When abnormality lifting of the combustion chamber internal pressure in front of jump spark ignition, the abnormalities in transition of a chamber pressure, etc. are detected from combustion room pressure data, it judges with abnormal-combustion conditions, such as a preignition condition and a knocking condition, and memory of 10 is carried out to Variable C.
[0052] Moreover, it is referred to as P= 0, when checking step S14 in a what time main routine with a flag P= 1 and exceeding the predetermined time R by the same variable C value.
[0053] At the time of C= 1, at the time of Rc=1C=2, the value of R will be set to Rc=1<Rc=2<Rc=3 by it at the time of Rc=2C=3, if the value of R changes the value of R as Rc=3.
[0054] It is referred to as P= 0 when the C value in the last main routine differs from this C value.
[0055] Step S15: Decision of being mode operation activation is performed, and in one case of 4, 6, and 9, it shifts to step S20, and Variable C shifts to step S16, in being other.
[0056] Step S16: Based on the value of Flag P, in the case of P= 0, ask for the target combustion rate according to an engine speed and a load, and put the result into Memory D with the map data in memory (thing equivalent to <u>drawing 5</u>). Moreover, a fundamental-points fire stage, a basic fuel-injection initiation stage, and basic fuel oil consumption are also calculated from the respectively same map data as <u>drawing 5</u> in memory (what graphic-display-ized the value given as an engine speed and a function of a load), and are paid to memory E' (1), E' (2), and E' (3), respectively. Then, it is made P= 1. However, when Variable C is 5, P= 0 asks for a target combustion rate based on the target combustion rate map for cold starts, and makes Memory D memorize the value. In no cases of P= 1, it carries out, but they shift to step S17.
[0057] A combustion rate means the rate of the fuel which burned by whenever [over the fuel which burns in 1 cycle combustion / a certain crank angle]. It is the approach of asking for the chamber-pressure data in two or more points predetermined [in combustion 1 cycle] in one approach by the primary approximation about the count approach of this combustion rate, and another is the approach of calculating the amount of heat release by the thermodynamic formula from the sampled pressure value, and asking for the combustion rate to a predetermined crank angle (for example, top dead center). The count result with both approaches very near true value was obtained. In this case, the data of a chamber pressure detect and ask for the chamber pressure in the crank angle of the 1st period of a before [from after termination of an exhaust stroke / the early stages of a compression stroke]. In this case, the pressure of a combustion chamber is a crank angle in within the limits in the condition of having fallen most and having approached atmospheric pressure, for example, the crank angle of a before [from after termination of an exhaust stroke / the early stages of a compression stroke] is a bottom dead point or its near. That is, in a four stroke cycle engine, the pressure of a combustion chamber declines and atmospheric pressure is approached as are shown in <u>drawing 6</u> , and the combustion gas of a combustion chamber is discharged by the exhaust stroke from the bottom dead point after explosion and a top dead center is approached. Like the inhalation line after a top dead center, the condition near atmospheric pressure is maintained for the new air conduction close, and a pressure is gradually heightened from the compression stroke after the bottom dead point where an exhaust valve 17 closes and is started through an intake stroke. The pressure of the

combustion chamber in one point is detected among the range which the pressure of such a combustion chamber declined and approached atmospheric pressure. Although the crank angle a0 in drawing 6 is taken to BDC, it may be after BDC as long as it is in early stages of a compression stroke. Of course, the crank angle in the inhalation-of-air process in front of BDC is sufficient. On the other hand, with a two-cycle engine, since new mind will be introduced from a crank case if a pressure declines, the pressure of a combustion chamber will decline further according to this if an exhaust port opens, and a scavenging port opens while the piston after explosion falls, as shown in drawing 21 , atmospheric pressure is approached. After the exhaust port has opened, a piston goes up from a bottom dead point, closing, then an exhaust port increase [a scavenging port], and a **** pressure increases [****** and compression] gradually. That is, from after termination of an exhaust stroke before the early stages of a compression stroke, after a scavenging port opens after the exhaust port opened and the exhaust port has opened after exhaust air initiation, and inhalation of air is started, between until an exhaust port closes and compression is started is said. In drawing 21 , the crank angle a0 is taken to BDC.

[0058] Jump spark ignition is performed in front of a compression backward top dead center or to the back. (Jump spark ignition is started in the crank angle expressed with an arrow head and S among drawing 6 and drawing 21 , respectively.) Jump spark ignition is started, it is slightly behind, and lights and combustion is started. The ignition initiation said by each claim is a flash when this firing combustion is started. That is, in the crank angle (drawing 21 drawing 6 , crank angle a1) of the 2nd period which is a period from compression stroke initiation to firing combustion initiation, the pressure of the **** interior of a room is detected. Then, two crank angles in the 3rd period which is a period until an exhaust stroke is started among an explosion combustion stroke from ignition initiation (firing combustion initiation) (it sets to drawing 6 and drawing 21) The pressure of a combustion chamber is detected in crank angle a2a3, the crank angles a2 and a4, the crank angles a3 and a4, the crank angles a2 and a5, the crank angles a3 and a5, or the crank angles a4 and a5. As for one crank angle, it is desirable between two crank angles in this period that it is a front [crank angle / used as the highest firing pressure]. Moreover, when the pressure of a combustion chamber detects in four or more crank angles, for example, the crank angle of five or more points, said by each claim, the number of the pressure survey crank angle points of the 1st or 2nd period may be made to increase. Moreover, in three or more crank angles, pressure detection may be carried out like [it is desirable and] the example of drawing 6 and drawing 21 [within the 3rd period]. By the diesel power plant, the fuel injection before a compression backward top dead center or to an after [a top dead center] combustion chamber is started, it is behind for a while, and combustion starts by spontaneous ignition. That is, by the diesel power plant, the ignition initiation indicated to each claim means the flash when this spontaneous ignition is started. In addition, as reach, spontaneous ignition searches for the ignition delay to initiation beforehand as an engine speed or data based on a load from fuel-injection initiation, this is woven in, it reaches and the pressure crank angle point within the pressure survey crank angle within the 2nd period and the 3rd period is memorized in memory as an engine speed or data based on a load, the pressure survey of a combustion chamber is performed.

[0059] the sum total of such 1st one period, the 2nd one period, and the 3rd two periods -- even if few, the chamber pressure of whenever [crank angle / of four points] is detected, and a combustion rate is calculated for this from a primary approximation. This approximation is combustion rate qx=a+b1*(P1-P0) +b2*(P2-P0)+... It is expressed with +bn* (Pn-P0).

[0060] As shown in a top type, to the pressure data P1-Pn, qx(es) are what applied the constant of b1-bn, and the thing which applied the constant a set up beforehand, and are expressed to what lengthened reference pressure P0 respectively.

[0061] It is what applied the constant to which C1-Cn were set beforehand, and the thing which applied the constant set up beforehand, and is expressed to that to which Pmi lengthened reference pressure P0 respectively to the pressure data P1-Pn similarly.

[0062] P0 is the chamber pressure of the point (as mentioned above for example, whenever [near the BDC / crank angle]) of atmospheric-pressure level, and in order to amend the offset voltage by the drift of a sensor etc., it is subtracted from each pressure value of P1-Pn here. Moreover, a firing pressure [in / in P1 / the crank angle a1 of the 1st period] and P2 are the chamber pressures in the

crank angle a2 of the 2nd period. P3-Pn(s) are the crank angles a3-an (this example n= 5) of the 3rd period.
[0063] A value with the combustion rate actual to accuracy to the predetermined crank angle after firing and the almost same value are computed by the operation by such easy primary approximation for a short time. Therefore, while being able to take out the energy by combustion efficiently by controlling engine ignition timing and an engine air-fuel ratio using such a combustion rate, when responsibility is raised and it performs lean combustion control and EGR control, operational status can be followed exactly and output fluctuation can be suppressed. Moreover, generating of NOx by combustion advancing rapidly can be prevented. In the 2nd qx calculation approach, the heating value generated between two pressure survey points (whenever [crank angle]) the differential pressure in both the pressure survey point -- **P and a volume-of-combustion-chamber difference -- if the ratio of specific beat and R make it as an average gas constant and P0 makes amounts, such as heat, and K the pressure value in BDC, P, and V and A the pressure value and volume-of-combustion-chamber value by the side of before [of **V and the two point of measurement]
Amount Qx=Aof heat release/(K-1) * (K+1) (/2***P***V+K*(P-P0) ***V+V***P)
It can ask by carrying out.
[0064] Moreover, the combustion rate to a predetermined pressure survey point selects a crank angle when combustion is completed mostly as a pressure survey point. It is what totaled what calculated the above-mentioned amount Qx of heat release for between [every] each pressure survey point that selected similarly the crank angle near at the time of ignition as a pressure survey point, and the meantime was measured. What totaled what calculated Above Qx about the between to a predetermined pressure survey point (predetermined crank angle) from the first pressure survey point is broken.
[0065] That is, it is heating-value x100(%) =(Q1+Q2+ ... +Qx)/(Q1+Q2+ ... +Qn) x100 of the heating value/all that burned by whenever [crank angle / of combustion rate qx= arbitration].
[0066] By the above count approaches, the chamber pressure in two or more predetermined crank angles can be measured (setting to step S112 of drawing 3), and the combustion rate to a predetermined crank angle can be computed to accuracy based on the data (setting to step S201 of drawing 7). The stable output and an engine revolution are obtained by controlling an engine using this combustion rate.
[0067] Step S17: Inhalation air-temperature information and inlet-pipe negative pressure information perform the amendment operation of the injection quantity for fuel injection. That is, since air density will become low if inhalation air temperature is high, a substantial air flow rate becomes less. For this reason, the air-fuel ratio in a combustion chamber becomes low. For this reason, the amount of amendments for reducing fuel oil consumption is computed.
[0068] Step S18: The basic fuel-injection initiation according to an engine load and an engine speed, basic fuel oil consumption, and a fundamental-points fire stage are called for at step S16, and are put in by E' (i). According to those information by which memory was carried out to the amount of amendments calculated at step S17 based on this, and memory A (i), the amount of fuel-injection amendments and the amount of ignition-timing amendments are calculated, and, in addition to a reference value, a controlled variable is calculated respectively. This controlled variable sets an ignition initiation stage to memory E (1), an ignition period is set to memory E (2), and an injection initiation stage and an injection termination stage are put into E (3) and E (4) for an injection initiation stage and an injection termination stage at F (3), F (4), and the time of P= 0 at the time of P= 1.
[0069] This is inputted into memory E (i). Similarly according to the information by which memory was carried out to memory A (i), the controlled variable of a servo motor group and a solenoid-valve group is computed, and it puts into memory G (i).
[0070] Step S19: Carry out actuation control of the actuators, such as a servo motor group and a solenoid-valve group, according to the controlled variable of memory G (i).
[0071] Step S20: An engine shutdown demand is judged, when Variable C is 6, it shifts to step S21, and in being other, it shifts to step S22.
[0072] Step S21: Set the halt data which set memory E(i) i=1-4 to 0, or carry out the flame failure of the ignition plug 400.

[0073] Step S22: Variable C judges that it is 9, when Variable C is the usual engine start of 9, shift to step S23, and when that is not right, shift to step S25.
[0074] Step S23: Set the data for making memory F (i) increase slightly the quantity of the angle of delay and fuel oil consumption for the data for start up currently beforehand put into memory, i.e., ignition timing.
[0075] Step S24: Drive a start-up motor.
[0076] Step S25: It is the case where Variable C is 4, and set the data which make the quantity of fuel oil consumption increase, extracting a throttle opening to memory F (i), if it is the data corresponding to the content of abnormalities, for example, OBAREBO, and is a flame failure and overheat.
[0077] Next, interruption routine [of drawing 3] ** is explained. This interruption routine ** will be performed by the main routine by interruption, if the crank signal of a predetermined include angle is inputted.
[0078] Step S111: Set a timer so that interruption routine ** may be performed for every predetermined crank angle, namely, so that the interrupt of whenever [following crank angle] may occur.
[0079] Step S112: Incorporate the pressure data which are whenever [crank angle / which the interrupt generated], and put into memory.
[0080] Step S113: If the pressure data of all crank angles are incorporated by memory, it will shift to step S114.
[0081] Steps S114-S115: Variable C confirms whether to be 10 or not, and, in the case of C= 10, performs and carries out the return of the abnormal-combustion prevention routine of step S115 as abnormal combustion. When that is not right, it moves to step S116.
[0082] Step S116: It confirms whether to be C= 2 and judges whether it is a transient, and it comes out so, and a transient control routine is performed by step S116a at a certain time, and it amends and carries out the return of ignition timing or A/F. Otherwise, it moves to step S117.
[0083] Step S117: It confirms whether to be C= 5, judges whether it is a cold start, and comes out so, and a cold start control routine is performed by step S117a at a certain time, and it amends and carries out the return of the ignition timing. Otherwise, it moves to step S118.
[0084] Step S118: It confirms whether to be C= 8 and judges whether it is the EGR control mode, and it comes out so, and an EGR control routine is performed by step S118a at a certain time, and it amends and carries out the return of an EGR rate or the ignition timing. Moreover, if that is not right, it will move to step S119.
[0085] Step S119: It confirms whether to be C= 3, judges whether it is lean combustion mode, and comes out so, and a lean combustion control routine is performed by step S119a at a certain time, and it amends and carries out the return of A/F or the ignition timing. Moreover, if that is not right, it will move to step S120.
[0086] Step S120: It confirms whether to be C= 7 and judges whether it is idling mode, and it comes out so, and an idling control routine is performed by step S120a at a certain time, and it amends and carries out the return of A/F or the ignition timing. Moreover, if that is not right, a MBT control routine will be performed at step S121, and the return of the ignition timing will be amended and carried out.
[0087] Next, interruption routine [of drawing 4] ** is explained. This interruption routine ** will be performed by the main routine by interruption, if a criteria crank signal is inputted.
[0088] Step S121: Since this interruption routine ** is performed once in an engine revolution and a predetermined crank angle, it measures a period.
[0089] Step S122: Calculate an engine speed.
[0090] Step S123: Set an ignition initiation stage, an ignition termination stage, an injection initiation stage, and an injection termination stage to a timer based on the control data of memory F(i) i=1-4. A timer starts an ignition and a fuel injection equipment to the set timing.
[0091] Next, the calculation of a target combustion rate explained by drawing 2 and drawing 3 is explained to a detail.
[0092] Drawing 5 is drawing of the map for asking for the target combustion rate according to an engine speed and a load. It asks from what map-ized the predetermined crank angle, for example, the

target combustion rate in 50 ATDC(s), as a target combustion rate at the time of lean combustion, and memory is carried out to the storage of a control unit 12. The configuration of the three dimensions as which a target combustion rate is determined by a load (Lx) and the engine speed (Rx) is shown. The target combustion rate in a predetermined service condition (Lx, Rx) is called for as FMB0 (Lxi, Rxi) and i=1-n.
[0093] According to operational status, the target combustion rate data in two or more crank angles are given as target combustion rate data. For example, the target combustion rate data of the predetermined crank angle in early stages of combustion and two or more predetermined crank angles of a combustion anaphase are given.
[0094] Drawing 6 is the graph of the chamber pressure of 1 cycle combustion of a four stroke cycle engine. As for an axis of ordinate, an axis of abscissa shows a firing pressure whenever [crank angle]. The firing pressures P0-P5 in six points of a0-a5 which whenever [crank angle] illustrated are detected, and a combustion rate is computed based on these pressure values. a0 is a bottom dead point location (BDC) which moves from inhalation to compression, and is in the condition almost near atmospheric pressure. a1 is after compression initiation and a2 is the crank angle before arriving at a top dead center (TDC) after jump spark ignition in S before jump spark ignition. Four points of a3-a5 are the crank angles which can be set like the explosion line after a top dead center. A combustion rate is computed based on the pressure data of these each point. In addition, in the case of the diesel power plant by which jump spark ignition is not carried out, a fuel is injected [near the top dead center] like FI. It is behind time to be equivalent to the crank angle after [d] injection initiation, and spontaneous ignition is carried out. The crank angle of spontaneous ignition is set to S. In this diesel power plant, control of fuel injection timing is carried out based on the difference between a target combustion rate or a target crank angle instead of control of ignition timing in an ignition spark system engine, respectively in a location survey combustion rate or a location survey crank angle. The tooth lead angle and angle-of-delay control of the injection initiation stage are carried out, and an injection termination stage is controlled so that the predetermined injection quantity is secured.
[0095] Next, the lean combustion control explained by drawing 3 is explained to a detail. Drawing 7 is the flow chart of the lean combustion control routine in the case of having desired value as a combustion rate of whenever [predetermined crank angle].
[0096] Step S201: Perform count of the combustion rate FMB (theta) and move to step S202.
[0097] Step S202: At the time of 0 (finishing [predetermined number activation of ignition-timing control]), Counter FCOUNT moves to step S203 in order to operate the amount of fuel supply. When that is not right, in order to perform amendment control of a fire stage, it moves to step S207.
[0098] Step S203: If the combustion rate FMB (theta) becomes beyond the criterion value FMBX, it will move to step S204. Otherwise, it moves to step S205.
[0099] Step S204: Operate it to a predetermined value loss-in-quantity side by the amount amendment unit FTDD of fuel supply by the side of loss in quantity of the fuel-supply correction factor FTD, and move to step S206.
[0100] Step S205: Operate it to a predetermined value loss-in-quantity side by the amount amendment unit FTDI of fuel supply by the side of loading of the fuel-supply correction factor FTD, and move to step S206.
[0101] Step S206: Set and (ignition-timing control is performed from a degree like) carry out the return of the count FCMAX of activation of ignition-timing control to Counter FCOUNT.
[0102] Step S207: Perform the amendment control routine of ignition timing, attain optimization of ignition timing, and move to step S208.
[0103] Step S208: Subtract from Counter FCOUNT one and carry out a return.
[0104] Drawing 8 can be diluted without causing output fluctuation and aggravation of the discharge of HC by obtaining the optimal firing stage and combustion speed by feedback amendment control of ignition timing and the amount of fuel supply, and the flow chart of a control routine with which it can improve and blowdown of NOx can also hold down fuel consumption is shown.
[0105] It has a target combustion rate in two or more crank angles, make an early combustion rate into the desired value for controlling a firing stage, and let the change rate of the combustion rate between at least two crank angles be the desired value for rate-of-combustion control.

[0106] As for rate-of-combustion control, firing stage control makes ignition timing the control input of the amount of fuel supply. this control input -- the difference of desired value and a detection value -- feedback -- things determine.
[0107] Step S500: Read the target combustion rate in a current engine speed and two or more crank angles corresponding to a load from the map memorized as target data at the time of lean combustion. The above is performed and it moves to step S501.
[0108] Step S5O1: Calculate the target rate of combustion from two or more target rates read at step S500. For example, the target rate of combustion BSPD is what **(ed) a changed part of the combustion rate of whenever [two crank angle] at spacing whenever [crank angle], and is called for.
[0109] BSPDthetal2=(FMBtheta2-FMBthetal)/(thetal)
When the desired value read in MABBU carries out combustion speed and is set up at FMBtheta2>FMBthetal and theta2>thetal step S500, activation of step S501 is unnecessary. The above is performed and it moves to step S502.
[0110] Step S502: Calculate the actual combustion rate in two or more crank angles to which the target combustion rate is set (it may be henceforth called a detection value and a detection combustion rate). From now on, combustion speed will also be calculated by the same formula as step S501. Next, it moves to step S503.
[0111] Step S503: Take the deflection of desired value and a detection value. For example, deflection deltaFBM of a combustion rate is calculated for the detection combustion rate FMB according to the detection combustion rate FMB (theta 1) and the difference of target combustion rate FMBtheta1.
[0112] Deflection deltaBSPD of combustion speed is calculated like deltaFMB=FMB(theta 1)-FMBthetal according to the detection combustion speed BSPD (theta 12), target combustion speed, and the difference of BSPDtheta12.
[0113]
More than BSPD=BSPD(theta 12)-BSPDtheta12 is calculated and it moves to step S504.
[0114] Step S504: Check the feedback prohibition flag of the amount amendment control of fuel supply. When a feedback prohibition flag is ON, it moves to step S509 and amendment control of the amount of fuel supply is not performed. Moreover, when a feedback flag is OFF, it moves to step S505, and processing is continued. Even if the feedback prohibition flag of combustion amount-of-supply amendment control is among lean combustion operation mode, it may be turned on. For example, in order to recognize dispersion between cylinders, it may be made rich for the purpose of the case where it is compulsorily made rich, or the improvement in the rate of exhaust gas clarification. When such, it is turned on between a predetermined cycle or predetermined time. The above is performed and it moves to step S505.
[0115] Step S505: Amendment control of the amount of fuel supply judges whether it is under [delay cycle] ********. A delay cycle is a cycle for giving and performing an interval to amendment. This absorbs the delay of a response, and surge-fluctuation. Amendment control will be performed if a delay counter is set to O, and it moves from it to step S506. When that is not right, it moves to step S506b.
[0116] Step S5O6: Here, the deflection of desired value and a detection value confirms whether it is the inside of an allowed value. This allowed value is prepared and engine hunting is prevented. If it becomes in an allowed value, amendment control will not be carried out but it will move to step S508. Otherwise, it moves to step S507 and amendment control of the amount of fuel supply is performed.
[0117] Step S507: Perform the amendment routine of the amount of fuel supply of drawing 10 , and move to step S508.
[0118] Step S5O8: Set a predetermined value to a delay counter so that it may become a count delay cycle of predetermined from next time, and move to step S509.
[0119] Step S5O6b: Reduce by one from the delay counter of the amount amendment control of fuel supply, and move to step S507b.
[0120] Step S507b: Equalize deflection. Moreover, the rate of change of a detection value can be calculated and the validity of amendment can also be evaluated in quest of the stability of

combustion. It moves to step S509, without amending by performing the above.
[0121] Step S509: Judge whether it is the delay cycle of ignition-timing amendment control. A delay cycle is a cycle for giving and performing an interval to amendment, and surge-fluctuation is absorbed. Amendment control will be performed if a delay counter is set to 0, and it moves from it to step S510. When that is not right, it moves to step S510b.
[0122] Step S510: Here, the deflection of desired value and a detection value confirms whether it is the inside of an allowed value. Engine hunting is prevented by this allowed value. If it becomes in an allowed value, amendment control will not be carried out but it will move to step S512. Otherwise, it moves to step S511 and amendment control of ignition timing is performed.
[0123] Step S511: Perform the amendment routine of ignition timing of drawing 9 , and move to step S512.
[0124] Step S512: Set and carry out the return of the predetermined value to a delay counter so that it may become a count delay cycle of predetermined from next time.
[0125] Step S510b: Reduce by one from the delay counter of ignition-timing amendment control, and move to step S51O **.
[0126] Step S51lb: Equalize deflection. Moreover, the rate of change of a detection value can be calculated and the validity of amendment can also be evaluated in quest of the stability of a period. A return is carried out without amending by performing the above.
[0127] Next, drawing 9 is the flow chart of the ignition-timing amendment control in the case of having desired value as a combustion rate of whenever [predetermined crank angle]. An operation of this ignition-timing amendment routine is shown in drawing 11 .
[0128] Step S151: Take deflection deltaFMB of the target combustion rate FMB and the actual value FMB (theta), and move to step S152.
[0129] Step S152: According to deflection deltaFMB, read the amendment variation gi in a map and move to step S153.
[0130] Step S153: Add the amendment variation gi to the ignition-timing correction value IGTD to last time, consider as the ignition-timing correction value IGTD, and move to step S154.
[0131] Step S154: If the ignition-timing correction value IGTD is forward, it will move to step S155a. If it is negative or 0, it will move to step S155b.
[0132] Step [step S155a -] S156a: If close does not require the ignition-timing correction value IGTD for the limit IGTDS by the side of a tooth lead angle, perform step S156a and carry out a return, applying a limit. If Limit IGTDS requires close, a return will be carried out as it is.
[0133] Step [step S155b -] S156b: If close does not require the ignition-timing correction value IGTD for the limit IGTDR by the side of the angle of delay, perform step S156b and carry out a return, applying a limit. If Limit IGTDR requires close, a return will be carried out as it is.
[0134] Next, the amount amendment routine of fuel supply in the case of calculating correction value according to deflection is shown in drawing 10 . An operation of this amount amendment routine of fuel supply is shown in drawing 12 .
[0135] Step S171: Take deflection deltaFMB of the target combustion rate FMB and the actual value FMB (theta), and move to step S172.
[0136] Step S172: Read the amendment variation gf in a map according to deflection deltaFMB, and move to step S173.
[0137] Step S173: Add the amendment variation gf to the correction value FTD of the amount of fuel supply to last time, consider as the correction value FTD of the amount of fuel supply, and move to step S174.
[0138] Step S174: If the correction value FTD of the amount of fuel supply is forward, it will move to step S175a. If it is negative or 0, it will move to step S175b.
[0139] Step [step S175a -] S176a: If close does not require the correction value FTD of the amount of fuel supply for the limit FTDMX by the side of loading, perform step S176a and carry out a return, applying a limit. If Limit FTDMX requires close, a return will be carried out as it is.
[0140] Step [step S175b -] S176b: If close does not require the correction value FTD of the amount of fuel supply for the limit FTDMN by the side of loss in quantity, perform step S176b and carry out a return, applying a limit. If Limit FTDMN requires close, a return will be carried out as it is.
[0141] In such lean combustion control, it dilutes infinite, reducing combustion dispersion and HC

blowdown. As a control-objectives value, it has a desired value map for lean combustion control.
[0142] In order to judge buildup of HC discharge, and the tolerance of output instability, let whenever [combustion rate / of a combustion anaphase /, or crank angle] be desired value. For example, whenever [crank angle / of the combustion rate in TDC50" and 70% of (b) combustion rates] can be set up as desired value whenever [(a) crank angle].
[0143] This desired value shows the tolerance of combustion aggravation. In the case of (a), when a combustion rate is smaller than desired value, when larger than desired value, the aggravation condition will be shown by the case of (b).
[0144] A lean combustion control routine is a subroutine of the combustion rate control routine performed for every ** engine revolution, and when the control mode determined by the main routine according to operational status is lean combustion control, it is performed.
[0145] If this lean combustion control routine is performed, loading and a actual combustion rate will be calculated for the desired value currently calculated beforehand, amendment control of ignition timing and the amount of fuel supply is performed by turns, and correction value is stored.
[0146] If a combustion rate is more than the inside of a criterion, that it can dilute further will judge and specified quantity reduction of the fuel will be carried out. When that is not right, it judges with rarefaction being impossible more, and specified quantity loading of the fuel is carried out. The number cycle after [these] operating the amount of fuel supply like performs amendment control of ignition timing, and carries out optimal C of the ignition timing, and it is made for a combustion rate to become desired value.
[0147] Drawing 13 is a graph which shows the inclination of change of the combustion rate when changing the amount of fuel supply. When more rich than proper A/F, in proper A/F, 8A will decrease the quantity of a fuel, if 8B is a1 with the larger combustion rate of location survey [in / as for 8C, Lean's case is shown from proper A/F, and / a predetermined crank angle (for example, B)] than a target combustion rate (for example, A). Moreover, if it is a2 [smaller than a target combustion rate (for example A)], the quantity of a fuel will be increased.
[0148] Moreover, if the crank angle of the location survey which reaches a predetermined combustion rate (for example, A) is b2 [larger] than a target crank angle (for example, B), the quantity of a fuel will be increased. If it is b1 [smaller than a target crank angle (for example, B)], the quantity of a fuel will be decreased.
[0149] Namely, when it is the initial value of the amount of fuel supply according to a load at least and the fuel is supplied to an engine, It has data with the initial value of the amount of fuel supply set up so that a lean mixture might be formed in a combustion chamber. The combustion rate in a predetermined crank angle among a load or an engine speed [whether it holds in memory as map data of the target combustion rate at least corresponding to one side, and] Whether the crank angle which reaches a predetermined combustion rate is held in memory as map data of the target crank angle at least corresponding to one side among a load or an engine speed on the other hand Detect the actual combustion rate to this predetermined crank angle, and it is based on the comparison with this detection combustion rate and a target combustion rate. the direction of a detection combustion rate -- smallness -- the time -- the amount of fuel supply -- increasing -- the direction of a detection combustion rate -- size -- the time -- the amount of fuel supply -- decreasing -- or -- Or detect the actual crank angle which reaches this predetermined combustion rate, and it is based on the comparison with this detection crank angle and a target crank angle. While the direction of a target crank angle is progressing, the amount of fuel supply is increased, and while the direction of a detection value crank angle is progressing, fuel consumption is raised, making lean combustion possible and falling exhaust air emission by carrying out one amount control of fuel supply of whether the amount of fuel supply is decreased.
[0150] Drawing 14 is drawing showing change of the combustion rate FMB by ignition-timing actuation. When the tooth lead angle of the 10A is being carried out from proper ignition timing, 10B shows the case where the angle of delay is being carried out from proper ignition timing, and if the combustion rate of the location survey in a predetermined crank angle (for example, B) is a1 [larger] than a target combustion rate (for example, A), it will carry out the angle of delay of proper ignition-timing and 10C. Moreover, if it is a2 [smaller than a target combustion rate (for example A)], a tooth lead angle will be carried out.

[0151] Moreover, if the crank angle of the location survey which reaches a predetermined combustion rate (for example, A) is b2 [larger] than a target crank angle (for example, B), a tooth lead angle will be carried out. If it is b1 [smaller than a target crank angle (for example, B)], the angle of delay will be carried out.

[0152] Namely, it has the initial value of ignition timing at least corresponding to one side as data among a load or an engine speed. The combustion rate in a predetermined crank angle among a load or an engine speed [whether it holds in memory as map data of the target combustion rate at least corresponding to one side, and] Whether the crank angle which reaches a predetermined combustion rate is held in memory as map data of the target crank angle at least corresponding to one side among a load or an engine speed on the other hand Detect the actual combustion rate to this predetermined crank angle, and it is based on the comparison with this detection combustion rate and a target combustion rate. the direction of a detection combustion rate -- smallness -- an event -- a fire stage -- advancing -- the direction of a detection combustion rate -- size -- whether ignition timing is delayed Or detect the actual crank angle which reaches this predetermined combustion rate, and it is based on the comparison with this detection crank angle and a target crank angle. By setting forward a fire stage the event of the direction of a target crank angle progressing, and carrying out one ignition-timing control of whether a fire stage is delayed the event of the direction of a detection value crank angle progressing Fuel consumption and drawing 15 to raise are graphs which show change of the data when performing lean combustion control, making lean combustion possible and falling exhaust air emission. Drawing 15 (a) shows an A/F value change, drawing 15 (b) shows change of the target combustion rate FMB by ignition-timing actuation, drawing 15 (c) shows the ignition-timing correction value IGT, and drawing 15 (d) shows the amount correction value of fuel supply. If lean combustion control is started, based on the target combustion rate FMB by ignition-timing actuation, with the ignition-timing correction value IGT, loading and loss in quantity are amended, by the amount amendment control of fuel supply, it will have data of the initial value of the amount of fuel supply, and proper amendment will be performed by a tooth lead angle and the angle of delay, and the amount correction value of fuel supply based on this so that A/F value may become fixed with a proper value.

[0153] Allowance width of face is given to a target combustion rate as lean combustion control. Namely, the larger 1st target combustion rate than the target combustion rate of map data, The 2nd target combustion rate smaller than the target combustion rate of map data is set up. the direction of a detection combustion rate -- the 2nd target combustion rate -- smallness -- the time -- the amount of fuel supply -- increasing -- When the direction of a detection combustion rate consists of a 1st target combustion rate size, the amount of fuel supply is decreased. The 1st target crank angle which it is made not to change the amount of fuel supply, or gave allowance width of face to the target crank angle, and progressed from the target crank angle of map data when a detection combustion rate was between the 1st target combustion rate and the 2nd target combustion rate, The 2nd target crank angle which was late for the target crank angle of map data is set up. While the detection crank angle is progressing from the 1st target crank angle, the amount of fuel supply is decreased. When the amount of fuel supply is increased when the direction of a detection value crank angle is behind the 2nd target crank angle, and a detection crank angle is between the 1st target crank angle and the 2nd target crank angle, it is good to carry out one to which it is made not to change the amount of fuel supply of those amount control of fuel supply. Or either the amount control of fuel supply based on the tooth-lead-angle angle-of-delay relation between the control based on the size relation between the above-mentioned 1st target combustion rate, the 2nd target combustion rate, and a detection combustion rate, the above-mentioned 1st target crank angle, the 2nd target crank angle, and a detection crank angle or ignition-timing control and both are carried out at the time at least of one side among whether a load is smaller than a predetermined value or there are few engine speeds than a predetermined value.

[0154] Drawing 16 is a graph with which A/F value shows the combustion rate at the time of predetermined crank angle ATDC50", and correlation of HC and a NOx discharge in the thin condition. Moreover, drawing 17 is a graph with which A/F value shows the combustion rate at the time of predetermined crank angle ATDC50", and correlation of output dispersion in the thin condition. For example, the combustion percentage FMBij at the time of predetermined crank angle

ATDC50" is 70%, there are few HC and NOx discharges and output dispersion is also small.
[0155] Moreover, a target crank angle can be searched for with the map data of drawing 18 . That is, in drawing 18 , when target crank angle CRAs0 (Rx, Lx) which are setting to target crank angle CRA which should reach a predetermined combustion rate, and should reach an axis of abscissa at a load (L) and an axis of ordinate to a predetermined combustion rate, for example, 60%, 70%, 80 etc.%, etc. are actual engine-speed rpm (Rx) and a actual engine load (Lx), it asks from a map. Target crank angle CRA0 (Rxi, Lxi) is calculated as i=1-n. The crank angle value data which reach two or more combustion rates as crank angle value data which reach a predetermined combustion rate in case a normal combustion condition is acquired are given.
[0156] Drawing 19 is a graph with which A/F value shows whenever [crank angle / at the time /% / of combustion rates / 70], and correlation of HC and a NOx discharge in the thin condition. Drawing 20 is a graph with which A/F value shows whenever [crank angle / at the time /% / of combustion rates / 70], and output dispersion in the thin condition. For example, thetaij(s) are 50 ATDC(s) whenever [crank angle / in case the predetermined combustion percentage FMBij is 70%], there are few HC and NOx discharges and output dispersion is also small.
[0157] Drawing 21 is the same graph of a chamber pressure as the above-mentioned four stroke cycle engine and drawing 6 to show the point for combustion rate measurement of said two-cycle engine detecting [combustion pressure data]. As mentioned above, chamber-pressure data are sampled whenever [crank angle / of six points]. Within the limits of an in [drawing] A is a crank angle field as for which the exhaust port is carrying out opening, and within the limits of B is a crank angle field as for which the scavenging port is carrying out opening. How to take whenever [each crank angle] (a0-a5) and the count approach are the same on the above-mentioned four stroke cycle engine and parenchyma, are step S113 of interruption routine ** of drawing 3 , detect the firing pressures P0-P5 in six points of a0-a5 which whenever [crank angle] illustrated, and compute a combustion rate based on these pressure values. Each example of this invention can adopt what supplies combustion with a carburetor.
[0158] In addition, in the above-mentioned lean combustion control, while carrying out ignition-timing control and said amount control of fuel supply based on said detection combustion rate or a detection crank angle at the time at least of one side among whether a load is smaller than a predetermined value or there are few engine speeds than a predetermined value, when there is not a load or an engine speed in said conditions, only ignition-timing control based on said combustion rate may be carried out.
[0159] Or ignition-timing control and the amount control of fuel supply may be carried out by turns. In this case, the angle of delay of the field consent fire stage when a detection combustion rate is larger than the larger 1st target combustion rate about ignition-timing control than the target combustion rate of map data is carried out. The tooth lead angle of the field consent fire stage when a detection combustion rate is smaller than the 2nd target combustion rate smaller than the target combustion rate of map data is carried out. Control held at ignition timing as it is when a detection value is a mean value of the 1st and 2nd target combustion rate is performed. About the amount control of fuel supply When a detection combustion rate turns into below the 2nd target combustion rate, the quantity of a fuel is decreased, and when larger than the other 2nd target combustion rate, it may be made to perform control which always increases the quantity of a fuel.
[0160] Moreover, in carrying out by turns, ignition-timing control of the 1st count of predetermined and the amount control of fuel supply of the 2nd count of predetermined may be carried out by turns.

[0161] In this control, the 2nd count of predetermined was made [more] than the 1st count of predetermined.
[0162] Smallness I see, it is the initial value of the amount of fuel supply according to a load at least, and while setting up so that a lean mixture may be formed in a combustion chamber when supplying the fuel to an engine, you may make it an engine load have data with the initial value of the amount of fuel supply set up so that empty fuel consumption of a lean mixture could be enlarged in lean combustion control of the above-mentioned example. Moreover, it may be made it making small than the target combustion rate which uses at the time of the 2nd service condition which carries out only the ignition-timing control based on a detection combustion rate or a detection crank angle for

the target combustion rate which uses at the time of one [at least] 1st service condition among whether the load which carries out ignition-timing control based on a detection combustion rate or a detection crank angle and the amount control of fuel supply is smaller than a predetermined value, or there are few engine time mark than a predetermined value.

[0163] Moreover, a detection combustion rate or a detection crank angle detects the firing pressure in at least four crank angles which consist of the crank angles from after termination of an exhaust stroke to the early stages of a compression stroke, crank angles from compression stroke initiation to ignition, and two crank angles in the period from ignition initiation to exhaust stroke initiation, and you may make it compute it based on these firing-pressure data.

[0164]

[Effect of the Invention] As described above, invention according to claim 1 detects the actual combustion rate to 1 or two or more predetermined crank angles. the comparison with this detection combustion rate and a target combustion rate -- being based -- the direction of a detection combustion rate -- smallness -- the time -- the amount of fuel supply -- increasing -- The actual crank angle which decreases the amount of fuel supply or reaches these 1 or two or more predetermined combustion rates when the direction of a detection combustion rate becomes size is detected. Based on the comparison with this detection crank angle and a target crank angle, while the direction of a target crank angle is progressing, the amount of fuel supply is increased. Performing the amount control of fuel supply based on the combustion rate to a predetermined crank angle, and reducing exhaust air emission, since one amount control of fuel supply of whether the amount of fuel supply is decreased is carried out while the direction of a detection value crank angle is progressing, lean combustion can be made possible and fuel consumption can be raised.

[0165] It can make lean combustion possible and can raise fuel consumption, it performing the amount control of fuel supply to easy and accuracy based on the combustion rate to a predetermined crank angle, and reducing exhaust-air emission, since invention according to claim 2 gives allowance width of face to a target combustion rate, gives allowance width of face to a target crank angle based on the target combustion rate of map data and carries out the amount control of fuel supply from the target crank angle of map data. If a certain amount of allowance width of face is prepared and control is not suspended in order to store a combustion rate in desired value (if it says strictly near desired value), under the effect of the reading error of data, disturbance (noise), combustion dispersion, etc., hunting of a combustion rate will become large and will have an adverse effect on an output. Therefore, allowance width of face is required.

[0166] Since the object of lean combustion is diluting as long as the desired value of a combustion rate is fulfilled, when larger than tolerance or it, the quantity of a fuel is decreased. However, when smaller than an allowed value, in order to dilute too much, it is necessary to increase the quantity of a fuel.

[0167] It is in tolerance without making the boundary line (decision value) of increase loss in quantity of a fuel the same as that of the desired value of a combustion rate as mentioned above, and it is stabilized, and rarefaction can be realized.

[0168] Engine power can be stabilized because invention according to claim 3 performs the amount control of fuel supply based on a load or an engine speed.

[0169] Invention according to claim 4 detects the actual combustion rate to 1 or two or more predetermined crank angles. the comparison with this detection combustion rate and a target combustion rate -- being based -- the direction of a detection combustion rate -- smallness -- an event -- a fire stage -- advancing -- The actual crank angle which delays ignition timing when the direction of a detection combustion rate becomes size, or reaches these 1 or two or more predetermined combustion rates is detected. Based on the comparison with this detection crank angle and a target crank angle, a fire stage is set forward the event of the direction of a target crank angle progressing. Performing ignition-timing control based on the combustion rate to a predetermined crank angle, and reducing exhaust air emission, since one ignition-timing control of whether a fire stage is delayed the event of the direction of a detection value crank angle progressing is carried out, lean combustion can be made possible and fuel consumption can be raised.

[0170] Invention according to claim 5 reducing exhaust air emission by carrying out by the amount control of fuel supply based on a detection combustion rate or a detection crank angle and the

ignition-timing control based on a combustion rate combining, it can make lean combustion possible and can raise fuel consumption. Moreover, in order to dilute in the optimal ignition timing, from the case where it carries out only by the amount control of fuel supply, it can dilute further and the stability of a fuel is not spoiled, either.
[0171] Invention according to claim 6 reducing exhaust air emission as carry out ignition-timing control and the amount control of fuel supply by turns, and different control should combine them, and boil them, it can make lean combustion possible and can raise fuel consumption. Moreover, the amount of fuel supply and ignition-timing fitness can be ****(ed) by carrying out by turns.
[0172] Invention according to claim 7 carries out ignition-timing control of the 1st count of predetermined, and the amount control of fuel supply of the 2nd count of predetermined by turns, reducing exhaust air emission by performing still more precise control, can make lean combustion possible and can raise fuel consumption.
[0173] Invention according to claim 8 being able to make [many] the 1st count of predetermined, being able to perform the amount control of fuel supply, being able to bring it close to the proper amount of fuel supply, and reducing exhaust air emission from the 2nd count of predetermined, it can make lean combustion possible and can raise fuel consumption.
[0174] In addition, further especially invention claim 7 and given in eight can absorb a time constant until it is reflected in combustion, when changing the amount of fuel supply, can prevent fault amendment and also has the effectiveness that the stability of combustion is securable.
[0175] Invention according to claim 9 having data of the initial value of the amount of fuel supply, securing accuracy and easy control, and reducing exhaust air emission, it can make lean combustion possible and can raise fuel consumption.
[0176] By making it smaller than the target combustion rate which uses the target combustion rate used at the time of the 1st service condition at the time of the 2nd service condition which carries out only ignition-timing control, invention according to claim 10 performing the amount control of fuel supply proper, and reducing exhaust air emission, it can make lean combustion possible and can raise fuel consumption.
[0177] Invention according to claim 11 can detect a firing pressure, and can compute it appropriately based on firing-pressure data.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the jump-spark-ignition type four stroke cycle engine which is two or more cylinders with which this invention is applied.
[Drawing 2] It is the flow chart of the main routine which controls various engine operational status.
[Drawing 3] It is drawing showing interruption routine **.
[Drawing 4] It is drawing showing interruption routine **.
[Drawing 5] It is drawing of the map for asking for the target combustion rate according to an engine speed and a load.
[Drawing 6] It is the graph of the chamber pressure of 1 cycle combustion of a four stroke cycle engine.
[Drawing 7] It is the flow chart of the lean combustion control routine in the case of having desired value as a combustion rate of whenever [predetermined crank angle].
[Drawing 8] It is the flow chart of the lean combustion control routine in the case of having two or more desired value as a combustion rate of whenever [predetermined crank angle].
[Drawing 9] It is the flow chart of the ignition-timing amendment control in the case of having desired value as a combustion rate of whenever [predetermined crank angle].
[Drawing 10] It is the amount amendment routine of fuel supply in the case of calculating correction value according to deflection.
[Drawing 11] It is drawing showing change of the combustion rate FMB by ignition-timing actuation.
[Drawing 12] It is drawing showing change of the combustion rate FMB by the amount actuation of fuel supply.
[Drawing 13] It is the graph which shows the inclination of change of the combustion rate when changing the amount of fuel supply.
[Drawing 14] It is drawing showing change of the combustion rate FMB by ignition-timing actuation.
[Drawing 15] It is the graph which shows change of the data when performing lean combustion control.
[Drawing 16] A/F value is the graphs which show the combustion rate at the time of predetermined crank angle ATDC50", and correlation of HC and a NOx discharge in the thin condition.
[Drawing 17] A/F value is the graphs which show the combustion rate at the time of predetermined crank angle ATDC50", and correlation of output dispersion in the thin condition.
[Drawing 18] It is drawing of the map for asking for whenever [according to an engine speed and a load / target crank angle].
[Drawing 19] A/F value is the graphs which show whenever [crank angle / at the time /% / of combustion rates / 70], and correlation of HC and a NOx discharge in the thin condition.
[Drawing 20] A/F value is the graphs which show whenever [crank angle / at the time /% / of combustion rates / 70], and output dispersion in the thin condition.
[Drawing 21] It is the same graph of a chamber pressure as drawing 6 of the above-mentioned four stroke cycle engine to show the point for the output torque of a two-cycle engine, and combustion rate measurement detecting [combustion pressure data].
[Description of Notations]

1 Engine
9 Crankshaft
10 Flywheel Starter Gear
11 Crank Angle Sensor
12 Control Unit
13 Combustion Chamber
25 Oxygen Density Sensor (O2 Sensor)
26 Temperature Sensor
31 Throttle Opening Sensor
32 Pressure-of-Induction-Pipe Force Sensor
34 Heat Ray Type Inhalation Air Content Sensor
36 Inhalation Air Temperature Sensor
105 Injector
106 Regulator
120 Exhaust Pipe Temperature Sensor
150 It is Sensor whenever [Catalyst Temperature].

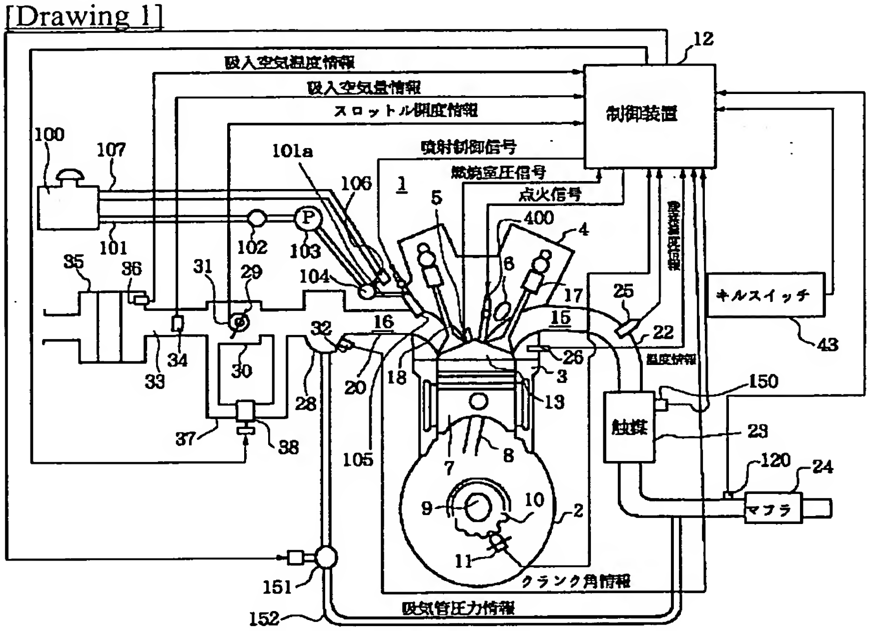
[Translation done.]

* NOTICES *

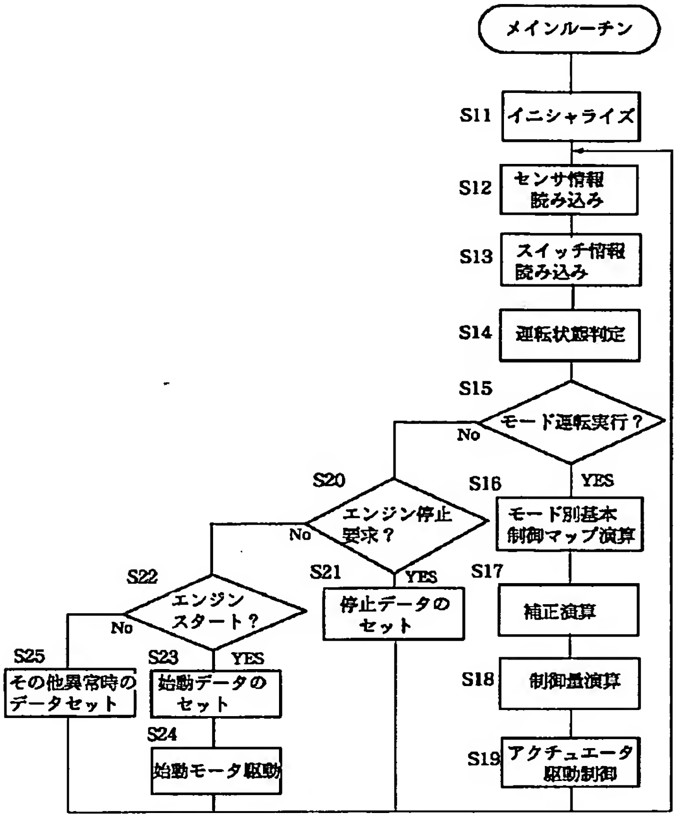
1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

DRAWINGS

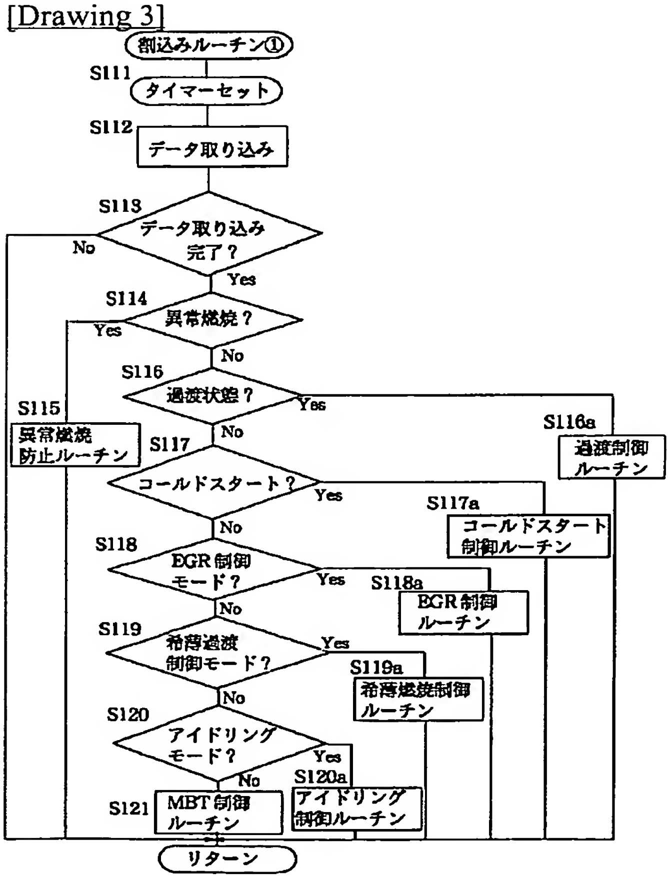
[Drawing 1]



[Drawing 2]



[Drawing 3]



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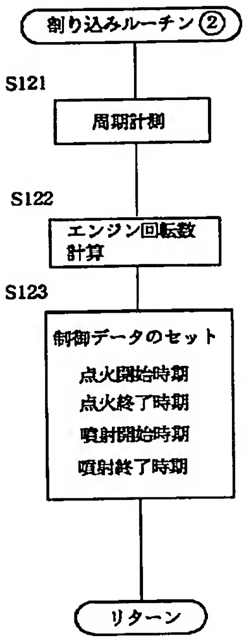

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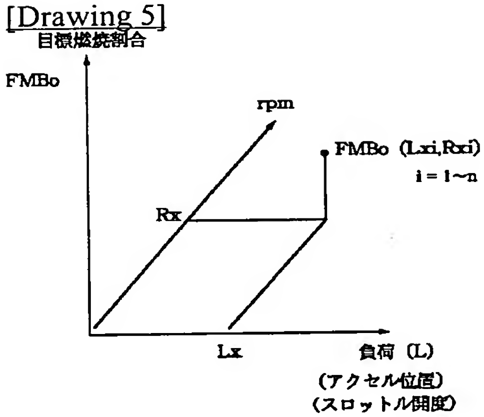
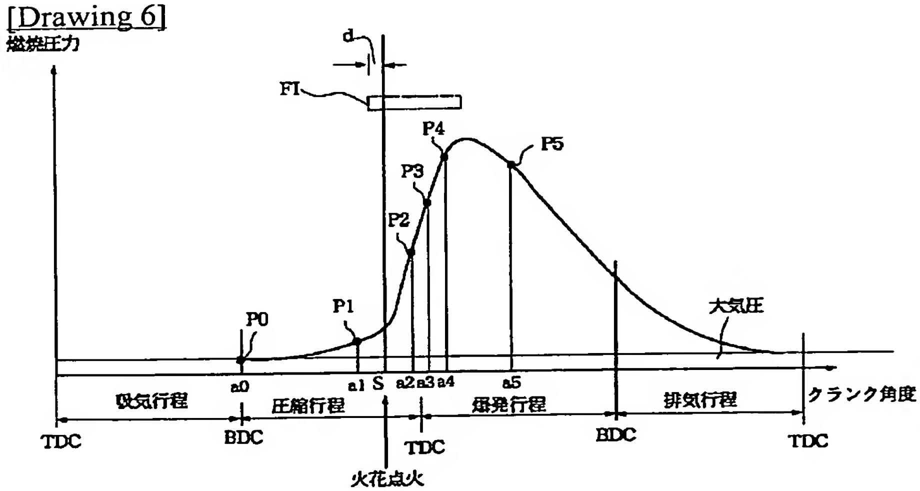
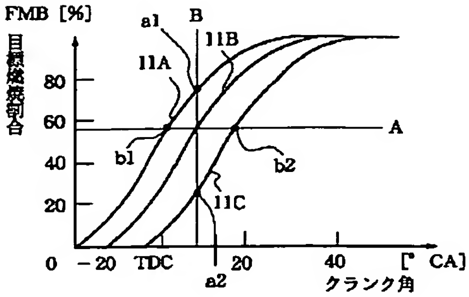


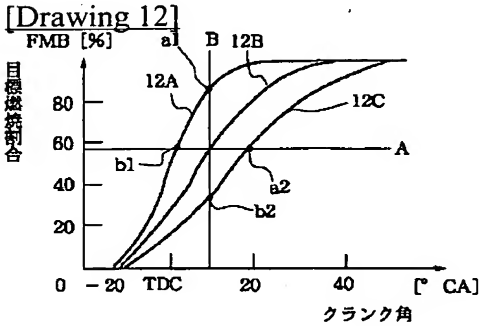
[Drawing 6]



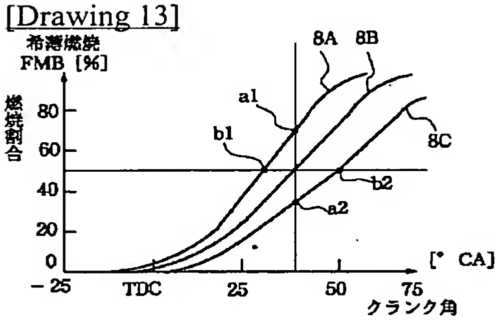
[Drawing 11]



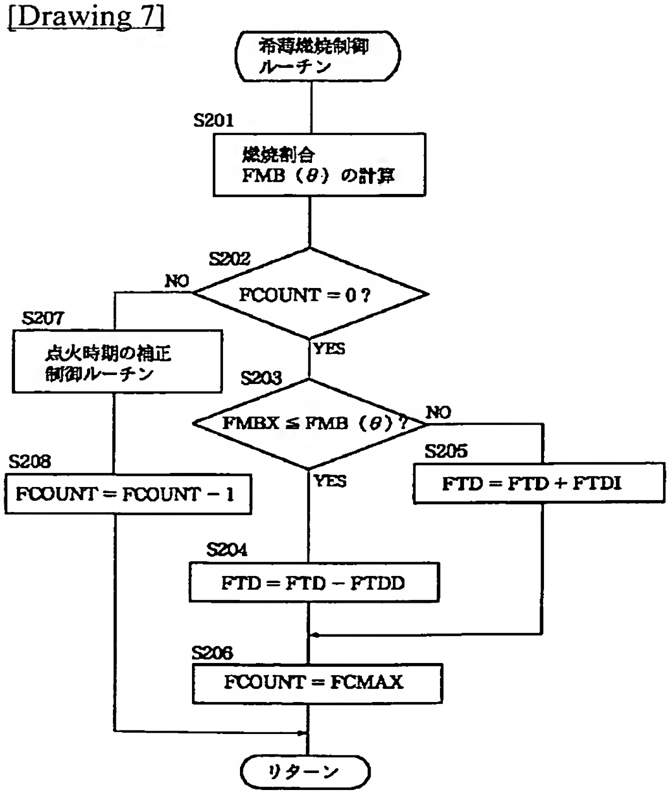
[Drawing 12]



[Drawing 13]



[Drawing 7]



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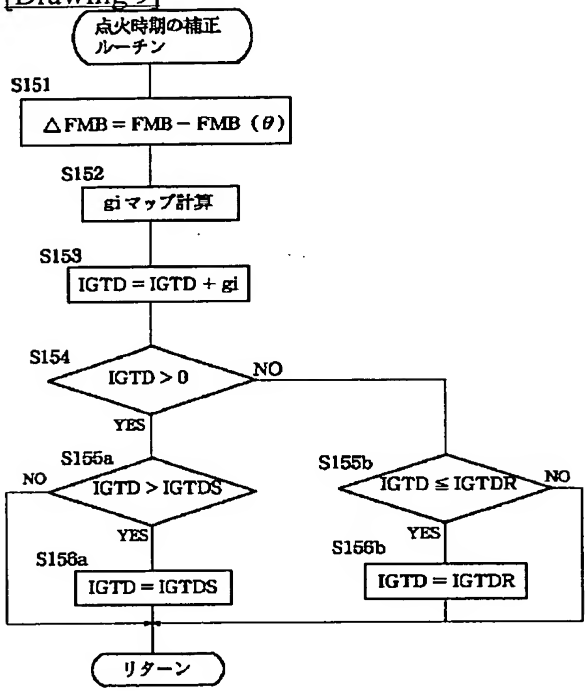
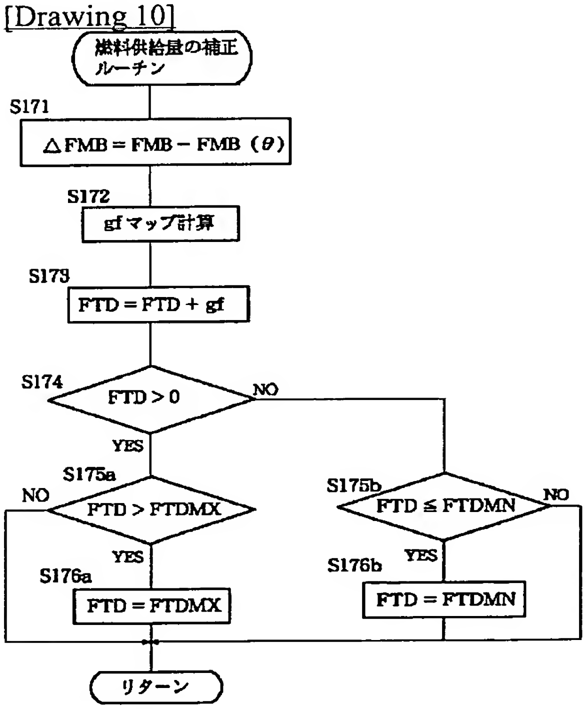
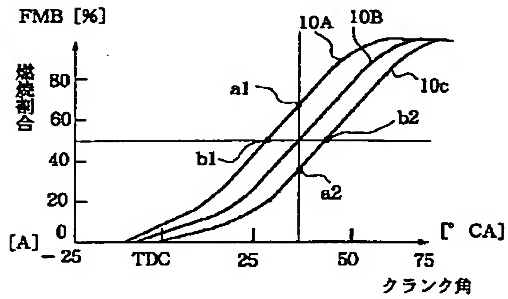


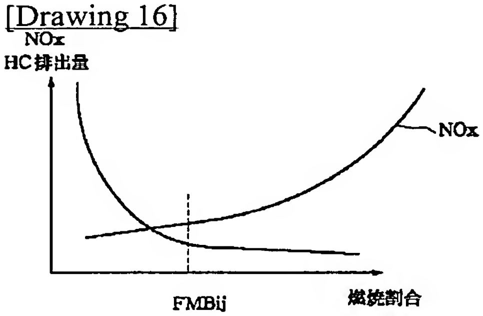
[Drawing 10]



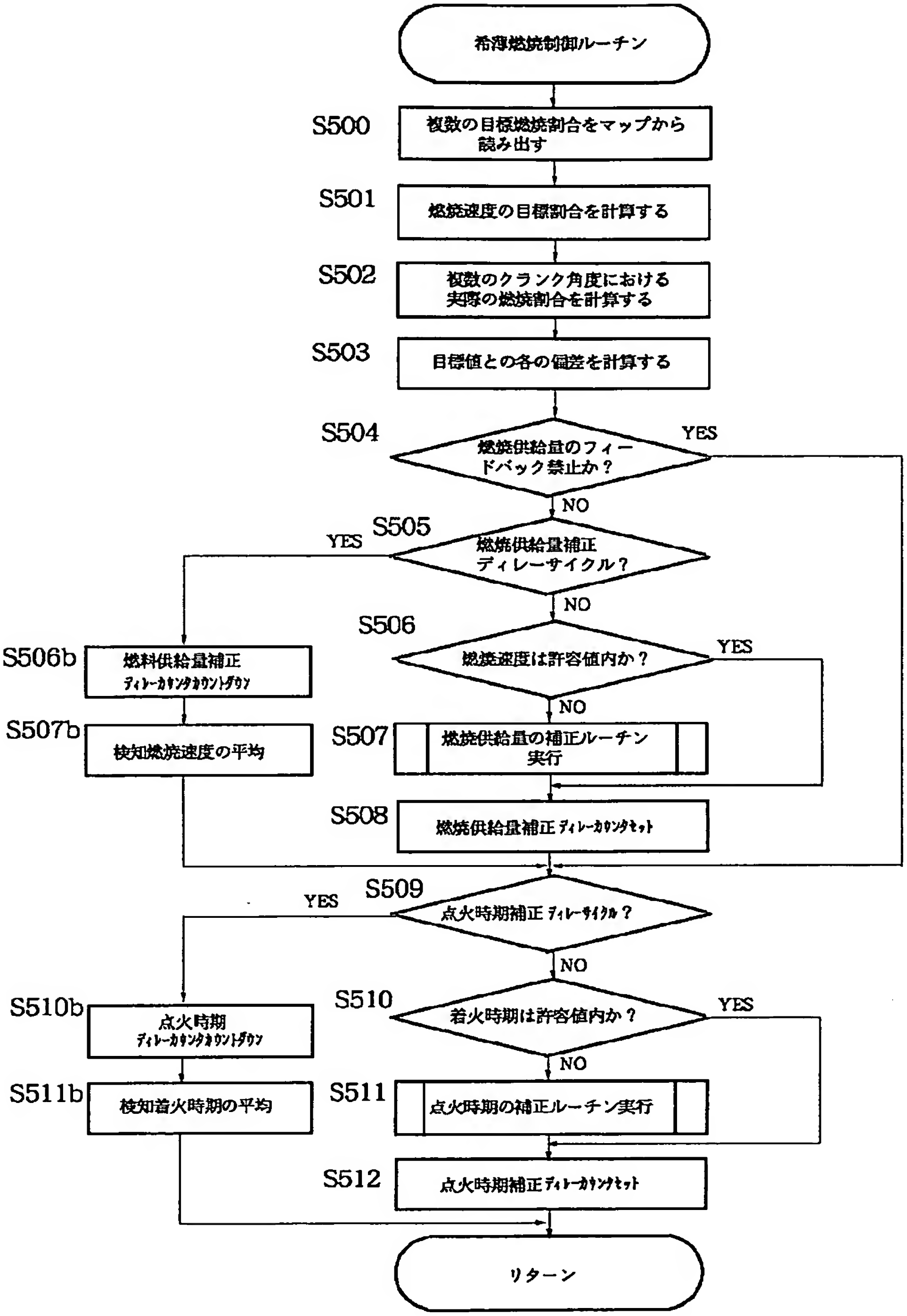
[Drawing 14]



[Drawing 16]



[Drawing 8]


希薄燃焼制御ルーチン
S500
複数の目標燃焼割合をマップから読み出す
S501
燃焼速度の目標割合を計算する
S502
複数のクランク角度における実際の燃焼割合を計算する
S503
目標値との各の偏差を計算する
S504
燃焼供給量のフィードバック禁止か？
YES
NO
S505
燃焼供給量補正ディレーサイクル？
YES
NO
S506
燃焼速度は許容値内か？
YES
NO
S506b
燃料供給量補正ディレーカウンタカウントダウン
S507b
検知燃焼速度の平均
S507
燃焼供給量の補正ルーチン実行
S508
燃焼供給量補正ディレーカウンタセット
S509
点火時期補正ディレーサイクル？
YES
NO
S510
着火時期は許容値内か？
YES
NO
S510b
点火時期ディレーカウンタカウントダウン
S511b
検知着火時期の平均
S511
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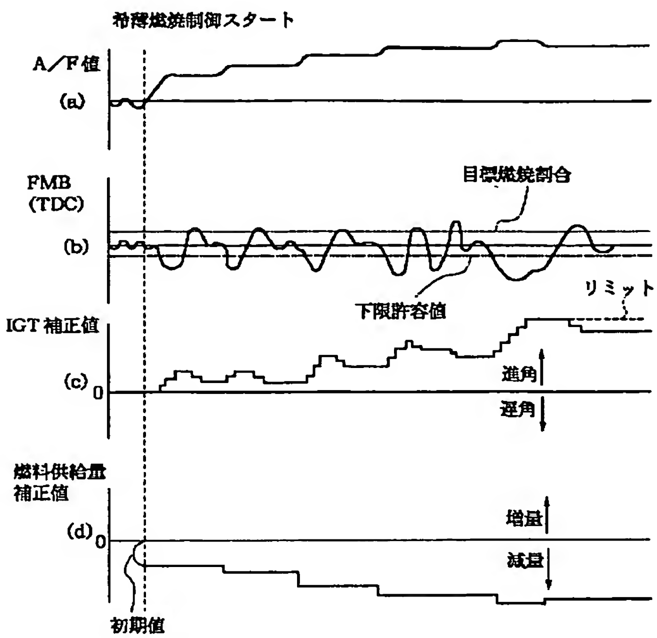
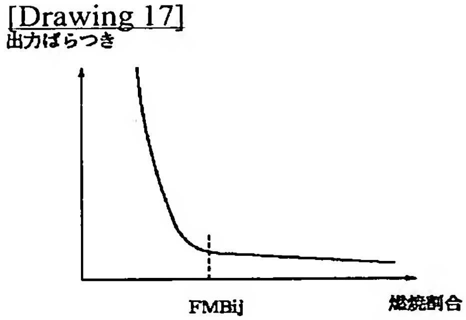
S512
点火時期補正ディレーカウンタセット
リターン

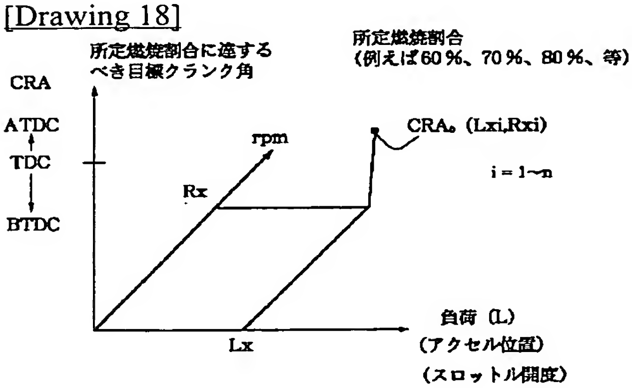
[Drawing 15]



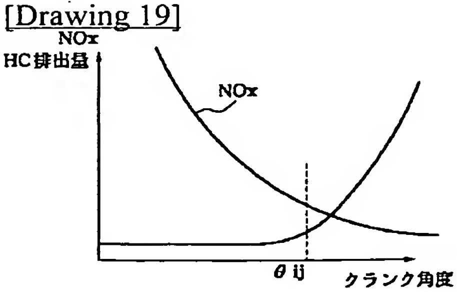
[Drawing 17]



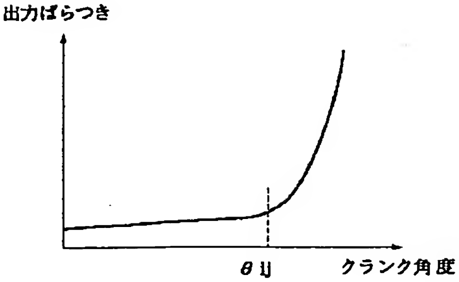
[Drawing 18]



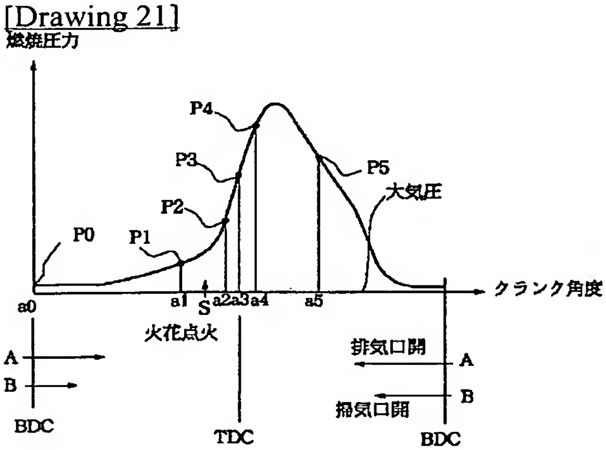
[Drawing 19]



[Drawing 20]



[Drawing 21]



[Translation done.]